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Green Economy and Sustainable Development: The Role of Green Innovation in Driving Economic Development

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ABSTRACT

This study examines the role of green innovation in promoting economic development within the framework of the green economy and sustainable development. Using an integrative literature review, the study synthesizes theoretical perspectives and empirical findings concerning green innovation, resource efficiency, economic productivity, and environmental sustainability. The findings indicate that green innovation can improve resource utilization, strengthen productivity, and create new economic opportunities. However, these benefits are not automatic and depend on technological capabilities, financial accessibility, environmental regulations, and institutional readiness. Resource efficiency emerges as a potential mechanism linking green innovation with economic development, although productivity improvements do not necessarily reduce overall environmental pressures. By integrating the Natural Resource-Based View and environmental innovation perspectives, this study proposes a conceptual framework explaining these relationships. The findings emphasize the importance of aligning technological advancement with environmental protection, institutional support, and inclusive economic growth to achieve long-term sustainable development.

ABSTRAK

Penelitian ini mengkaji peran inovasi hijau dalam mendorong pembangunan ekonomi melalui perspektif ekonomi hijau dan pembangunan berkelanjutan. Dengan menggunakan pendekatan integrative literature review, penelitian ini menyintesis berbagai perspektif teoretis dan temuan empiris mengenai inovasi hijau, efisiensi sumber daya, produktivitas ekonomi, dan keberlanjutan lingkungan. Hasil sintesis menunjukkan bahwa inovasi hijau berpotensi meningkatkan efisiensi penggunaan sumber daya, memperkuat produktivitas, dan menciptakan peluang ekonomi baru. Namun, manfaat tersebut tidak terjadi secara otomatis karena dipengaruhi oleh kapabilitas teknologi, akses pembiayaan, regulasi lingkungan, dan kesiapan kelembagaan. Efisiensi sumber daya diidentifikasi sebagai mekanisme potensial yang menghubungkan inovasi hijau dengan pembangunan ekonomi, meskipun peningkatan produktivitas belum tentu mengurangi tekanan lingkungan secara keseluruhan. Melalui integrasi Natural Resource-Based View dan perspektif inovasi lingkungan, penelitian ini mengusulkan kerangka konseptual yang menjelaskan hubungan tersebut. Temuan penelitian menegaskan pentingnya menyelaraskan kemajuan teknologi, perlindungan lingkungan, dukungan kelembagaan, dan pertumbuhan ekonomi yang inklusif untuk mencapai pembangunan berkelanjutan dalam jangka panjang.

1. INTRODUCTION

Economic development has traditionally been assessed through indicators such as gross domestic product growth, investment expansion, and industrial productivity. However, economic growth does not always correspond with improvements in environmental quality. Expanding production and consumption require substantial amounts of energy, raw materials, land, and other natural resources. When these resources are exploited without adequate environmental management, economic development may generate additional challenges, including pollution, ecosystem degradation, and increasing pressure on natural resource availability. The United Nations Environment Programme (UNEP, 2024) reports that global natural resource extraction has tripled over the past five decades. This trend raises an important question about the direction of economic

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development: how can economies maintain growth while preserving the environmental systems that support production, consumption, and human well-being?

Growing concerns about these challenges have encouraged the development of the green economy as an approach that seeks to reconcile economic progress with environmental protection. UNEP (2011) defines a green economy as one that improves human well-being and social equity while significantly reducing environmental risks and ecological scarcity. This perspective suggests that economic development should not be evaluated solely by the amount of wealth generated, but also by how resources are utilized and how economic benefits are distributed. The concept is closely related to sustainable development, which emphasizes meeting present needs without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). Although the two concepts are interconnected, they are not identical. The green economy emphasizes the transformation of economic activities toward environmentally responsible production and consumption, while sustainable development provides a broader framework encompassing economic, environmental, and social objectives.

The transition toward a green economy has become increasingly important amid climate change, resource depletion, and continued dependence on fossil fuels. The International Energy Agency (IEA, 2024) estimated that global investment in clean energy would exceed USD 2 trillion in 2024, reflecting growing interest in renewable energy, electrification, and low-emission technologies. Nevertheless, increasing investment does not necessarily indicate that the transition is progressing equally across countries. Developing economies often face limited access to financing, technological capabilities, infrastructure, and institutional support. This creates a development dilemma because countries seeking to accelerate economic growth may also encounter greater difficulties financing environmentally sustainable transformation. Consequently, the green economy should be understood not merely as an environmental agenda but also as an economic development challenge involving investment, technological accessibility, and institutional capacity.

In Indonesia, the transition toward a green economy is particularly relevant because economic activities remain closely connected to natural resource utilization, industrial production, and energy demand. The National Development Planning Agency (Bappenas, 2019) introduced low-carbon development as part of a broader effort to integrate economic growth with environmental sustainability. Indonesia also strengthened its climate commitments through the Enhanced Nationally Determined Contribution, targeting greenhouse gas emission reductions of 31.89% through domestic efforts and 43.20% with international support by 2030 (Republic of Indonesia, 2022). These commitments demonstrate the increasing importance of environmental considerations in national development planning. However, policy commitments alone cannot guarantee a successful green transition. The more fundamental challenge concerns how environmental objectives can be translated into technological investment, industrial transformation, resource-efficient production, and measurable economic improvements.

One factor that may accelerate this transformation is green innovation. Unlike conventional innovation, which is frequently associated with productivity improvements, market expansion, or competitive advantage, green innovation explicitly incorporates environmental objectives into technological, organizational, and business development activities. Rennings (2000) explains that environmental innovation has distinctive characteristics because its benefits may extend beyond the innovating enterprise to society through reduced environmental damage. Green innovation can therefore create both private economic value and broader environmental benefits. Examples include renewable energy technologies, energy-efficient production systems, cleaner manufacturing processes, environmentally preferable materials, and technologies that support waste reduction and resource recovery. These innovations may provide opportunities to improve productivity while reducing the environmental pressures associated with economic activities.

Nevertheless, the relationship between green innovation and economic development is not necessarily straightforward. Environmentally responsible technologies often require substantial initial investment, specialized knowledge, skilled labor, and supportive institutional arrangements. For businesses operating with limited financial resources, adopting green technologies may increase short-term costs even when long-term efficiency improvements are possible. Porter & van der Linde (1995) argue that appropriately designed environmental regulations can stimulate innovation and improve resource productivity, potentially offsetting some compliance costs. However, this argument should not be interpreted as evidence that every environmental regulation or green innovation automatically improves competitiveness. The economic outcomes of environmental innovation depend on technological capabilities, market conditions, industry characteristics, and the ability of organizations to respond effectively to regulatory and environmental pressures.

Empirical research further illustrates the complexity of this relationship. Doran & Ryan (2012) examine the connections between environmental regulation, eco-innovation, and firm performance, highlighting the importance of distinguishing different innovation activities and their economic implications. Similarly, Ghisetti & Rennings (2014) demonstrate that the relationship between environmental innovation and profitability varies according to the characteristics of the innovation. Innovations that improve energy and resource efficiency may generate economic benefits through lower operating costs, while innovations primarily intended to reduce environmental externalities may involve different financial consequences. These findings suggest that green innovation should not be treated as a uniform activity with universally positive economic outcomes. Instead, its contribution depends on the mechanisms through which environmental improvements interact with production efficiency, innovation costs, and market opportunities.

From a sustainable development perspective, these relationships become even more complex because economic growth, environmental protection, and social welfare do not always advance simultaneously. Green innovation may increase productivity, create new industries, and stimulate investment, but technological transformation may also change labor requirements, production structures, and the distribution of economic opportunities. The Organisation for Economic Co-operation and Development (OECD, 2011) emphasizes that green growth requires policies that encourage innovation and investment while addressing environmental constraints. This perspective suggests that the success of green economic transformation should be assessed through more than the adoption of environmentally friendly technologies. It should also consider improvements in resource productivity, environmental quality, employment opportunities, and the long-term resilience of economic activities.

Existing studies have contributed valuable insights into environmental innovation, firm performance, resource efficiency, and green economic growth. However, these discussions frequently emphasize different levels of analysis. Some studies examine green innovation as a source of firm competitiveness, while others focus on its contribution to energy efficiency, emission reduction, or broader economic development. Although these perspectives are complementary, their separation creates a need for a more integrated explanation of how green innovation contributes to sustainable economic development. In particular, further conceptual synthesis is required to clarify the mechanisms connecting green innovation with resource productivity and economic performance, the conditions under which environmental and economic benefits can be achieved simultaneously, and the roles of public policy and institutional capacity in supporting this process. This distinction is important because increasing green innovation activities does not necessarily mean that an economy has achieved sustainable development.

Against this background, this study aims to examine the role of green innovation in promoting economic development through the perspectives of the green economy and sustainable development. Specifically, it explores the relationships between green innovation, resource efficiency, economic productivity, and environmental sustainability while identifying the factors that facilitate or constrain their integration. Using an integrative literature review approach, the study seeks to develop a conceptual synthesis explaining how green innovation may contribute to sustainable economic transformation. Its main contribution lies in connecting economic and environmental perspectives while critically recognizing that green innovation is not an automatic solution to development challenges. Rather, its effectiveness depends on technological capabilities, market conditions, policy support, and institutional readiness. By integrating these dimensions, the study provides a foundation for understanding how green innovation can support economic development without overlooking the environmental and social conditions required for long-term sustainability.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

2.1. Green Economy and Sustainable Development

The green economy represents an approach to economic development that seeks to improve human well-being while reducing environmental degradation and resource depletion. According to the United Nations Environment Programme (2011), green economic development emphasizes resource efficiency, low-carbon economic activities, and social inclusion. This perspective challenges conventional growth models that prioritize economic expansion without adequately considering environmental consequences. Meanwhile, sustainable development provides a broader framework that integrates economic progress, environmental protection, and social welfare across generations (World Commission on Environment and Development, 1987). Although closely related, the green economy and sustainable development have different conceptual roles. The green economy emphasizes changes in production, consumption, investment, and resource utilization,

whereas sustainable development represents the broader objective of maintaining economic, environmental, and social well-being. The OECD (2011) argues that green growth requires policies capable of encouraging innovation and investment while preventing further depletion of natural resources. Consequently, economic growth can contribute to sustainable development when improvements in productivity are accompanied by responsible resource management and environmental protection.

2.2. Green Innovation and Economic Development

Green innovation refers to the development or improvement of products, production processes, technologies, and organizational practices that reduce environmental impacts while creating economic value. Rennings (2000) explains that environmental innovation differs from conventional innovation because its benefits extend beyond individual firms through reduced pollution and improved environmental quality. Green innovation may therefore contribute to economic development by improving resource productivity, reducing operational inefficiencies, and creating opportunities for environmentally oriented industries. However, the economic contribution of green innovation depends on its characteristics and implementation conditions. Porter & van der Linde (1995) suggest that appropriately designed environmental regulations can stimulate innovation and improve resource productivity. Nevertheless, Ghisetti & Rennings (2014) demonstrate that different types of environmental innovation may produce different profitability outcomes. These findings indicate that green innovation should not automatically be associated with economic growth. Its contribution depends on whether environmental improvements generate sufficient operational benefits, market opportunities, or productivity gains to justify implementation costs.

2.3. Resource Efficiency and Environmental Sustainability

Resource efficiency provides an important connection between green innovation and sustainable economic development. It refers to the ability to generate economic value while reducing unnecessary consumption of energy, raw materials, water, and other productive resources. Green innovations that improve production processes or resource management may reduce operating costs while limiting environmental pressures. From this perspective, resource efficiency can support both economic productivity and environmental sustainability. However, efficiency improvements do not necessarily guarantee reductions in total environmental impacts. Increased production may offset savings achieved through more efficient resource utilization. The United Nations Environment Programme (2024) emphasizes the growing pressures associated with global resource extraction, demonstrating the importance of addressing both resource productivity and overall consumption. Therefore, the contribution of green innovation should be evaluated through measurable economic and environmental outcomes rather than technological adoption alone.

2.4. Theoretical Integration and Research Gap

The relationship between green innovation and sustainable economic development can be explained through the Natural Resource-Based View and the innovation-oriented perspective of environmental regulation. Hart (1995) argues that pollution prevention, product stewardship, and sustainable development capabilities can become sources of competitive advantage. Meanwhile, Porter & van der Linde (1995) emphasize that environmental pressures may encourage innovations that improve resource productivity. Together, these perspectives suggest that environmental responsibility can create economic opportunities when supported by appropriate technological and organizational capabilities. Nevertheless, existing literature frequently examines green innovation, economic performance, and environmental sustainability as separate research concerns. This creates a need for a more integrated explanation of how green innovation contributes to economic development through resource efficiency and productivity improvements. Accordingly, this study positions green innovation as a potential driver of sustainable economic transformation, with resource efficiency serving as a key operational mechanism and policy support, technological capabilities, and institutional readiness acting as important enabling conditions. This integration provides the conceptual foundation for examining the contribution of green innovation to economic development within the broader objectives of the green economy and sustainable development.

3. RESEARCH METHOD

3.1. Research Design

This study adopts a qualitative approach using an integrative literature review to examine the role of green innovation in promoting economic development within the broader context of the green economy and sustainable development. An integrative review allows the combination of theoretical perspectives and empirical findings to develop a more comprehensive understanding of relationships across different research contexts (Torraco, 2005; Snyder, 2019). The analysis focuses on green innovation, resource efficiency, economic productivity, and environmental sustainability, with particular attention to the technological, institutional, and policy conditions influencing their relationships.

3.2. Literature Search and Selection

The literature search is designed to cover scientific publications indexed in Scopus, Web of Science, ScienceDirect, SpringerLink, and Google Scholar, focusing primarily on studies published between 2015 and 2026. Foundational publications published before this period are included when necessary to establish the theoretical framework. Search terms include green economy, green innovation, eco-innovation, sustainable development, resource efficiency, economic growth, and environmental sustainability, combined using Boolean operators. Literature selection prioritizes peer-reviewed studies that directly examine the relationships between environmental innovation, economic performance, and sustainable development. Relevant institutional reports are also considered to provide policy context and supporting evidence. Publications with limited relevance to the research objectives or insufficient methodological information are excluded.

3.3. Data Analysis and Conceptual Synthesis

The selected literature is analyzed through thematic synthesis, drawing on the principles of thematic analysis proposed by Braun & Clarke (2006). The analysis involves identifying relevant concepts, comparing research findings, and organizing the literature into major themes: green innovation and economic performance, resource efficiency and environmental outcomes, and institutional conditions supporting sustainable transformation. Particular attention is given to differences and inconsistencies across studies rather than assuming that green innovation always produces positive economic effects. The resulting synthesis integrates the Natural Resource-Based View with the innovation-oriented perspective of environmental regulation to develop a conceptual explanation of how green innovation may contribute to sustainable economic development. The proposed relationships are interpreted as theoretical propositions rather than empirically validated causal effects.

4. DATA ANALYSIS AND DISCUSSION

4.1. Green Innovation as a Driver of Economic Transformation

The literature indicates that green innovation has evolved from an environmentally oriented business activity into an increasingly important component of economic transformation. Traditionally, technological innovation has been associated with productivity growth, industrial competitiveness, and market expansion. However, the growing economic consequences of climate change, resource depletion, and environmental degradation have encouraged researchers to reconsider the relationship between innovation and development. Green innovation introduces an additional dimension to this relationship by emphasizing the creation of economic value through technologies, products, and organizational practices that reduce environmental pressures. Rennings (2000) explains that environmental innovation differs from conventional innovation because it can generate benefits beyond the innovating organization. This characteristic makes green innovation relevant not only to business competitiveness but also to broader economic and environmental development. The synthesis of previous studies suggests that green innovation contributes to economic development through several interconnected mechanisms. First, environmentally oriented technologies can improve production efficiency by reducing unnecessary energy and material consumption. Second, green products and services may create new market opportunities, particularly where consumers, investors, and governments increasingly value environmental performance. Third, green innovation can stimulate technological learning and industrial restructuring by encouraging businesses to develop new production capabilities. These mechanisms indicate that the economic contribution of green innovation is not limited to the direct financial performance of individual enterprises. Its broader relevance emerges when technological improvements influ-

ence resource productivity, investment decisions, industrial activities, and the development of environmentally responsible markets.

Takalo et al. (2021), through a systematic literature review of green innovation research, demonstrate the increasing attention given to environmental innovation across different organizational and technological contexts. Their review highlights the diversity of approaches used to examine green innovation, suggesting that its economic implications cannot be explained through a single technological or managerial perspective. Similarly, Oduro et al. (2022) identify several interconnected research areas, including green innovation management, environmental strategy, organizational performance, and stakeholder relationships. These findings suggest that green innovation should be understood as a multidimensional process rather than merely the introduction of environmentally friendly products. More recent quantitative evidence supports this interpretation while demonstrating important limitations. Zhao et al. (2026), in a meta-analysis of 48 empirical investigations, report positive but relatively modest associations between green innovation and environmental performance ($r = 0.172$), financial performance ($r = 0.191$), and innovation performance ($r = 0.143$). Their findings also indicate substantial heterogeneity across studies, suggesting that innovation outcomes depend on industry characteristics, geographical conditions, and the types of green innovation implemented. These results are important because they challenge the assumption that environmental innovation necessarily produces substantial economic benefits. Although the overall relationships are positive, their magnitude and variation indicate that green innovation should be treated as a potential contributor to economic performance rather than a universal guarantee of improved outcomes.

This distinction becomes particularly important when moving from firm-level performance to national economic development. A company may increase profitability by adopting an energy-efficient production system, but the contribution of that innovation to national development depends on its wider adoption, domestic value creation, employment implications, and environmental consequences. Green innovation can generate economic opportunities through new industries and technological activities, yet it may also require substantial investment and create adjustment pressures for businesses dependent on conventional technologies. Consequently, the economic significance of green innovation depends on both the value created by new technologies and the ability of economic institutions to manage the transition. The Natural Resource-Based View provides a theoretical explanation for these relationships. Hart (1995) argues that organizational capabilities associated with pollution prevention, product stewardship, and sustainable development can become strategically valuable resources. From this perspective, environmental responsibility may contribute to competitiveness when firms develop capabilities that competitors cannot easily reproduce. However, competitive advantage at the firm level should not be confused with sustainable economic development at the national level. An enterprise may become more competitive without generating substantial improvements in environmental quality or social welfare. Therefore, the contribution of green innovation to development should be evaluated through its combined effects on productivity, resource utilization, environmental outcomes, and economic opportunities. Overall, the literature suggests that green innovation can support economic transformation by changing how value is created and how resources are utilized. Nevertheless, its contribution remains conditional on technological effectiveness, investment feasibility, market acceptance, and institutional support. This finding provides the basis for examining resource efficiency as an important mechanism connecting green innovation with sustainable economic growth.

4.2. Resource Efficiency as a Mechanism Linking Green Innovation and Economic Growth

Resource efficiency emerges as one of the most important mechanisms through which green innovation may contribute to economic development. In conventional production systems, economic expansion frequently depends on increasing the consumption of energy, raw materials, water, and other productive inputs. Green innovation offers an alternative approach by improving the productivity of existing resources and reducing avoidable losses. This relationship is economically significant because inefficient resource utilization increases production costs, while environmentally damaging production processes can generate broader costs that are not fully reflected in market prices. Sun et al. (2023) provide relevant empirical evidence by examining green innovation, resource efficiency, and green economic growth in the Emerging Seven economies, including Indonesia, during 2010–2021. Using a generalized method of moments approach, their study identifies positive and statistically significant relationships between green innovation, resource efficiency, and green economic growth. This finding is particularly important because it extends the discussion beyond in-

dividual firms and considers the contribution of environmentally oriented innovation to economic development in emerging economies. However, the results should be interpreted within the characteristics of the countries, variables, and estimation methods examined. They do not establish that identical relationships necessarily exist across all developing economies or industrial sectors.

The economic mechanism underlying resource efficiency can be illustrated through production activities. A manufacturing enterprise that introduces technology to reduce material losses may produce the same quantity of output using fewer raw materials. Lower input requirements can reduce operating expenses and improve productivity. At the same time, reduced material consumption may decrease waste generation and environmental pressure. When similar improvements occur across multiple enterprises and industries, they may contribute to broader resource productivity and economic competitiveness. Nevertheless, the extent of these benefits depends on implementation costs, technological reliability, and the ability of firms to maintain operational improvements. Ghisetti & Rennings (2014) offer a critical perspective by demonstrating that the profitability implications of environmental innovation differ according to innovation characteristics. Innovations that reduce energy and resource consumption may generate financial savings, whereas innovations primarily intended to reduce environmental externalities may not produce equivalent private economic returns. This distinction helps explain why some green technologies are adopted relatively quickly while others require regulatory incentives or financial assistance. Businesses are more likely to invest in environmental improvements when the expected benefits are sufficiently clear and economically feasible.

However, improved resource efficiency should not automatically be interpreted as reduced environmental degradation. A distinction must be made between relative and absolute resource consumption. Relative improvements occur when resource use increases more slowly than economic output, while absolute improvements require actual reductions in resource consumption or environmental pressures despite economic expansion. For example, a factory may reduce electricity consumption per unit of output while increasing total electricity consumption because production expands substantially. In such circumstances, productivity improves, but the overall environmental burden may continue to increase. The European Environment Agency (2012) emphasizes the importance of distinguishing relative from absolute decoupling when evaluating the environmental consequences of economic growth. Similarly, UNEP (2024) reports that global resource extraction has increased substantially over recent decades, demonstrating that improvements in production efficiency have not eliminated growing pressures on natural systems. These findings reveal an important limitation of resource-efficiency strategies: greater efficiency can support sustainability, but its environmental contribution depends on whether total resource use and ecological impacts are also controlled.

This issue also raises questions about the measurement of green economic development. Conventional indicators such as GDP growth or industrial productivity may show positive economic performance without fully accounting for pollution, resource depletion, and environmental damage. The OECD (2026) emphasizes the relevance of environmentally adjusted productivity measures that incorporate environmental externalities alongside conventional production inputs. Such approaches suggest that the economic value of green innovation should be assessed not only through additional output but also through the environmental costs associated with generating that output. From this synthesis, resource efficiency can be positioned as a potential operational mechanism linking green innovation with economic development. Green technologies may improve resource productivity, which can support economic performance while reducing environmental pressures. However, the relationship should not be interpreted as an empirically established mediation effect in the present review. Its significance lies in providing a theoretically grounded explanation of how innovation may contribute to economic growth under conditions of environmental responsibility.

4.3. Green Innovation, Environmental Sustainability, and the Quality of Economic Growth

The literature further indicates that green innovation has implications for the quality of economic growth, particularly when environmental consequences are incorporated into development assessment. Economic expansion can increase income, investment, and employment, but these improvements may be accompanied by pollution, ecosystem degradation, and increasing resource dependence. Consequently, sustainable development requires consideration of whether economic progress can be maintained without generating environmental pressures that undermine future productive capacity. The green economy perspective challenges the assumption that economic and environmental objectives must always conflict. UNEP (2011) argues that

investments in resource efficiency, low-carbon technologies, and environmentally responsible economic activities can support development while reducing ecological risks. Nevertheless, this perspective should not be interpreted as suggesting that every green investment immediately generates positive economic returns. Environmental technologies may involve high initial costs, long investment recovery periods, and uncertainties related to technological performance or market demand. Their contribution therefore depends on the relationship between immediate implementation costs and longer-term economic and environmental benefits.

Evidence from global energy investment illustrates both the opportunities and inequalities associated with green transformation. The International Energy Agency (2024) estimated that global energy investment would exceed USD 3 trillion in 2024, with approximately USD 2 trillion directed toward clean energy technologies and infrastructure. However, emerging and developing economies outside China were expected to account for only around 15% of global clean energy investment. These figures indicate that the global transition toward cleaner technologies is expanding, but investment opportunities remain unevenly distributed. For developing economies, the challenge is not simply recognizing the importance of green innovation but securing sufficient financial and technological resources to participate effectively in the transition. This uneven distribution has important implications for sustainable development. Countries with stronger financial systems, technological infrastructure, and research capabilities may be better positioned to develop and commercialize green technologies. In contrast, countries with limited investment capacity may remain dependent on imported technologies or conventional production systems. As a result, the benefits of green innovation may be concentrated in economies that already possess relatively advanced technological capabilities. Without appropriate policy interventions, the green transition could therefore reproduce existing economic inequalities rather than reduce them.

The relationship between green innovation and environmental sustainability also depends on the type of innovation implemented. Green process innovation may reduce energy consumption, material losses, and pollution during production. Green product innovation may introduce goods that require fewer resources during use or generate lower environmental impacts across their life cycles. Organizational green innovation may improve environmental management through purchasing policies, employee training, and production planning. These different innovation types can contribute to sustainability through distinct mechanisms, making it inappropriate to assess their effectiveness using a single performance indicator. Zhao et al. (2026) reinforce this argument by identifying differences in performance relationships across green innovation categories and research contexts. Their findings suggest that integrating green product and process innovations may be more beneficial than treating them as isolated initiatives. However, the substantial variation across studies indicates that the benefits of integration remain dependent on organizational capabilities and implementation conditions. Similarly, Hendryadi & Sulistyowati (2026), in a systematic literature review of green innovation and financial performance, report that positive relationships are common but not universal. They identify organizational capabilities, government support, and market conditions as factors influencing the financial outcomes of green innovation.

A further concern involves the possibility that environmental improvements in one activity may create additional environmental pressures elsewhere. For example, the production of renewable energy equipment requires minerals, manufacturing processes, transportation, and eventual waste management. Similarly, replacing conventional products with environmentally preferable alternatives may shift environmental impacts across different stages of the product life cycle. Therefore, green innovation should be evaluated according to its broader environmental consequences rather than relying exclusively on the environmental characteristics of the final product. These findings suggest that the contribution of green innovation to sustainable development depends on its ability to improve economic performance while reducing overall environmental pressures. Economic growth becomes more sustainable when technological progress supports resource conservation, environmental protection, and long-term productive capacity. However, environmental sustainability cannot be inferred solely from increased green investment, innovation activity, or market competitiveness. Measurable environmental outcomes remain essential for evaluating whether economic transformation is genuinely sustainable.

4.4. Environmental Regulation, Institutional Capacity, and Green Innovation

The literature consistently identifies public policy and institutional conditions as important influences on

green innovation. Environmental technologies frequently generate benefits that extend beyond the organizations making the investment. Reduced pollution, improved air quality, and lower environmental risks can benefit society, even when the innovating enterprise does not receive direct financial compensation for these improvements. This creates an economic challenge because private investment decisions may not fully reflect the social value of environmental innovation. Rennings (2000) explains that environmental innovation is influenced by both technological opportunities and regulatory pressures. Unlike conventional innovation, which may be driven primarily by market demand and technological development, green innovation often requires institutional arrangements that encourage businesses to account for environmental consequences. Environmental standards, financial incentives, public research support, and market-based instruments may therefore influence the development and adoption of green technologies.

Porter & van der Linde (1995) propose that appropriately designed environmental regulations can stimulate innovation and encourage more productive resource utilization. Their argument challenges the traditional assumption that environmental regulation necessarily reduces competitiveness by increasing business costs. However, the potential for innovation-related benefits depends on regulatory design, technological opportunities, and organizational responses. Regulations that impose costs without supporting feasible technological adjustment may create financial pressure, particularly for enterprises with limited resources. Recent literature supports a more conditional interpretation of environmental policy. Li et al. (2024), through a review of policy instruments and green innovation, identify positive contributions from different environmental policy approaches while emphasizing the complexity of their relationships with corporate performance. This suggests that policy effectiveness cannot be assessed simply by whether environmental regulation exists. Its design, consistency, enforcement, and interaction with business capabilities are equally important.

Additional evidence from a 2026 meta-analysis of environmental regulation and green innovation performance indicates a statistically significant but modest overall association, with substantial differences across policy instruments, industries, and research settings. These findings reinforce the argument that environmental regulation can encourage innovation, but the strength and direction of its contribution depend on implementation conditions. Regulatory pressure alone may be insufficient when businesses lack access to financing, technical expertise, or viable technological alternatives. Institutional capacity is particularly relevant in developing economies, where green transformation may be constrained by financing gaps, limited research infrastructure, and differences in administrative effectiveness. The International Energy Agency (2024) identifies financing costs and investment imbalances as major challenges affecting clean energy development in emerging and developing economies. These constraints indicate that green economic transformation requires more than environmental targets. It also depends on the availability of financial institutions, technological assistance, infrastructure, and policies capable of reducing investment uncertainty.

Indonesia provides a relevant context for understanding these challenges. The country's Enhanced Nationally Determined Contribution establishes emission reduction targets of 31.89% through domestic efforts and 43.20% with international support by 2030 (Republic of Indonesia, 2022). These commitments establish an important policy direction, but achieving them requires changes in energy systems, industrial production, technological investment, and resource management. The central issue is therefore how national environmental commitments can be translated into economically feasible innovation activities across industries and enterprise sizes. The synthesis suggests that policy support and institutional readiness should be treated as enabling conditions rather than automatic determinants of green innovation success. Financial incentives may encourage investment, but their effectiveness depends on technological suitability and implementation capacity. Environmental regulations may stimulate innovation, but inconsistent enforcement or insufficient technical support can reduce their impact. Consequently, green economic policies should combine environmental objectives with practical measures that strengthen technological capabilities, investment accessibility, and organizational adaptation.

4.5. Integrating Green Innovation, Economic Development, and Sustainable Development

The preceding findings indicate that the relationship between green innovation and sustainable economic development involves several interconnected processes rather than a single direct pathway. Green innovation may improve resource efficiency, stimulate technological development, and create new economic opportunities. However, these improvements do not necessarily produce sustainable development unless they

also contribute to environmental protection and economically viable transformation. Similarly, resource efficiency can improve productivity, but increased production may offset environmental savings. These relationships suggest the need for an integrated conceptual framework that distinguishes innovation activities, operational mechanisms, economic outcomes, and broader sustainability objectives. The Natural Resource-Based View and the innovation-oriented perspective of environmental regulation provide complementary theoretical foundations for this integration. Hart (1995) explains how environmentally responsible resource management can become a source of strategic value, while Porter & van der Linde (1995) emphasize the potential role of environmental pressures in stimulating innovation and resource productivity. Rennings (2000) further highlights the distinctive economic characteristics of environmental innovation, particularly the presence of benefits that extend beyond individual organizations. Together, these perspectives suggest that green innovation can contribute to economic development when technological improvements are supported by appropriate organizational and institutional conditions.

The empirical literature provides additional support for this conceptual integration. Sun et al. (2023) identify positive relationships between green innovation, resource efficiency, and green economic growth in emerging economies. Ghisetti & Rennings (2014) demonstrate that the economic benefits of environmental innovation vary according to innovation characteristics, while Zhao et al. (2026) identify positive but heterogeneous associations between green innovation and organizational performance. These findings suggest that resource efficiency represents a plausible connecting mechanism, but its effectiveness depends on the type of innovation, implementation conditions, and economic context. Figure 1 presents the integrated conceptual framework proposed from the literature synthesis. The framework positions green innovation as a potential driver of resource efficiency and economic development, while sustainable development represents the broader objective encompassing economic viability, environmental quality, and social well-being. Environmental regulation, technological capabilities, financial accessibility, and institutional readiness are conceptualized as enabling conditions influencing the effectiveness of these relationships.

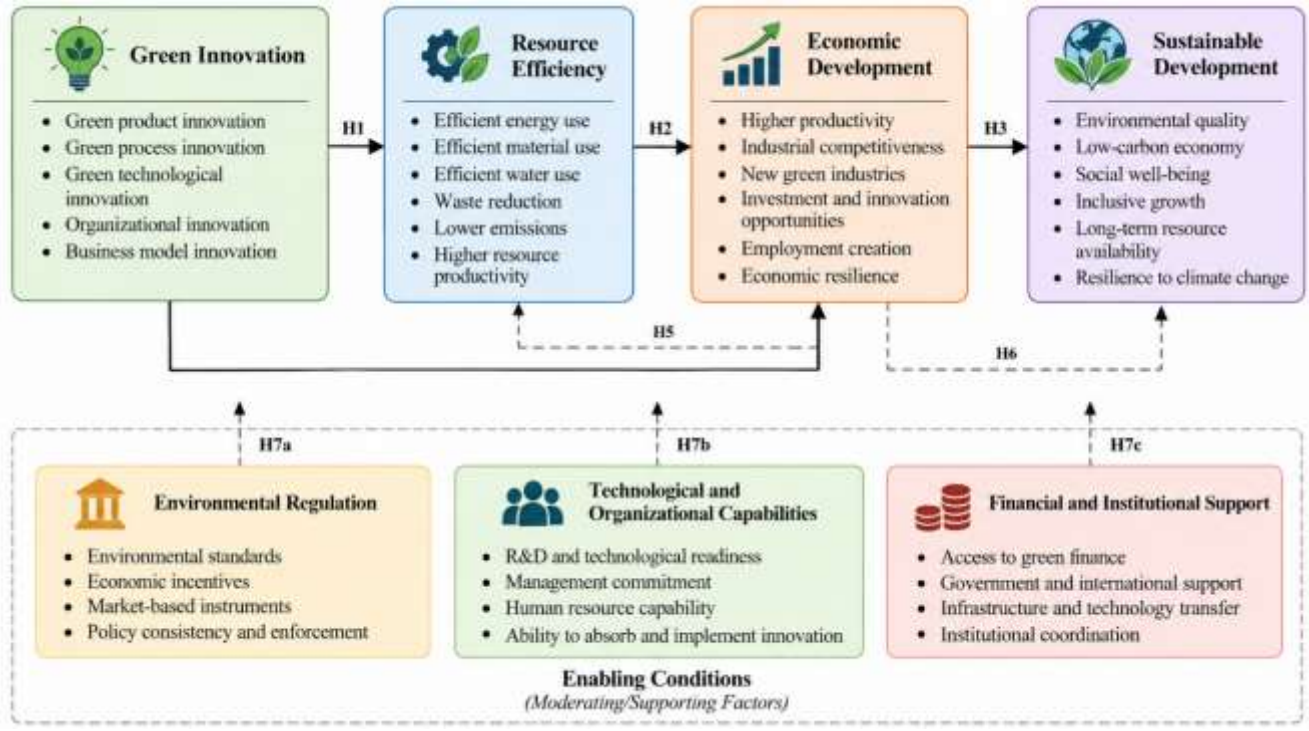


Figure 1. Integrated Conceptual Framework

The framework makes an important distinction between economic growth and sustainable development. Economic growth represents an increase in economic activity or output, while sustainable development requires broader consideration of environmental and social consequences. Green innovation may contribute to growth through productivity improvements, investment, and market development, but its contri-

bution to sustainable development depends on whether these benefits are achieved without increasing unacceptable environmental pressures or creating substantial social disadvantages. The distinction also clarifies why technological innovation alone is insufficient. Green technologies may create opportunities for more efficient production, but their actual contribution depends on organizational capabilities, economic incentives, and the wider institutional environment. Consequently, sustainable development should be understood as the outcome of interactions among technological progress, resource management, economic structures, and public policy rather than the automatic result of green innovation adoption.

Table 1. Synthesis of Major Findings and Their Implications for Sustainable Economic Development

Research dimension	Main findings from the literature	Critical interpretation	Supporting studies
Green innovation and economic performance	Green innovation is generally associated with improved performance, although the relationships vary across studies.	Positive associations do not establish universally positive economic outcomes.	Ghisetti & Rennings (2014); Zhao et al. (2026)
Green innovation and resource efficiency	Environmental innovation can improve resource productivity and support green economic growth.	Resource efficiency is a potential mechanism, not an empirically validated mediator in this review.	Sun et al. (2023); Hart (1995)
Environmental sustainability	Green technologies may reduce pollution and resource intensity.	Efficiency gains do not necessarily reduce absolute environmental pressures.	UNEP (2024); European Environment Agency (2012)
Environmental regulation	Policy instruments can encourage environmentally oriented innovation.	Effectiveness depends on regulatory design, business capabilities, and implementation conditions.	Porter & van der Linde (1995); Li et al. (2024)
Financing and institutional readiness	Investment and technological capabilities influence the implementation of green transformation.	Unequal access to financing may widen differences between advanced and developing economies.	International Energy Agency (2024); OECD (2011)
Sustainable economic development	Green innovation may support economic productivity and environmental improvement.	Economic growth must be distinguished from broader environmental and social sustainability.	Rennings (2000); Sun et al. (2023); UNEP (2011)

Table 1 demonstrates that the literature generally recognizes the potential contribution of green innovation to economic and environmental performance. However, the findings also reveal several important qualifications. First, innovation benefits differ according to technological characteristics and economic context. Second, resource efficiency does not necessarily guarantee absolute environmental improvement. Third, environmental regulation and institutional support can facilitate innovation, but their effectiveness depends on implementation capacity. These qualifications suggest that the relationship between green innovation and sustainable development should be interpreted as conditional rather than universally positive.

An important theoretical contribution of the proposed framework is its separation of technological inputs, operational mechanisms, economic outcomes, and sustainability objectives. Previous research has frequently examined these dimensions from different perspectives. By integrating them, this study provides a conceptual explanation of how green innovation may contribute to economic development through improvements in resource efficiency and productivity while recognizing the institutional conditions required for environmentally responsible transformation. From a policy perspective, the findings suggest that governments should prioritize the quality and effectiveness of green innovation rather than focusing exclusively on technological adoption or investment volume. Policies can encourage businesses to develop environmentally responsible technologies while strengthening financing mechanisms, technical assistance, and institutional coordination. Equally important, green economic performance should be evaluated using indicators that capture both economic productivity and environmental consequences.

For future research, the proposed framework offers opportunities to examine whether resource efficiency mediates the relationship between green innovation and economic development, and whether institutional readiness and environmental policy strengthen or constrain these relationships. Comparative studies across developing and advanced economies could help explain why green innovation generates different

economic outcomes. Longitudinal research would also be valuable because technological investment costs and environmental benefits may emerge over different time horizons. Overall, the synthesis suggests that green innovation can become an important instrument for sustainable economic development, but its contribution depends on more than technological progress. Resource efficiency provides a potential mechanism through which innovation can improve productivity and reduce environmental pressures, while public policy and institutional capacity influence the feasibility of implementation. The central finding is that green innovation supports sustainable development most meaningfully when economic productivity, resource conservation, environmental protection, and institutional readiness are addressed as interconnected development priorities.

5. CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

This study concludes that green innovation has the potential to contribute to sustainable economic development by improving resource efficiency, strengthening productivity, and encouraging environmentally responsible economic activities. However, the literature indicates that these contributions are neither automatic nor uniform across industries and economic contexts. Green technologies may reduce production costs, improve resource utilization, and create new market opportunities, but their effectiveness depends on technological capabilities, investment feasibility, and institutional support. The integration of the Natural Resource-Based View and the innovation-oriented perspective of environmental regulation suggests that resource efficiency represents a potential mechanism connecting green innovation with economic development. Nevertheless, higher economic productivity does not necessarily guarantee environmental sustainability, particularly when increased production offsets efficiency improvements. The central conclusion is that green innovation contributes most meaningfully to sustainable development when economic growth is accompanied by measurable environmental improvements, responsible resource management, and supportive institutional conditions.

The findings offer theoretical, practical, and policy implications for advancing the green economy. Theoretically, this study develops an integrated conceptual framework that connects green innovation, resource efficiency, economic development, and sustainable development while recognizing environmental regulation, organizational capabilities, and institutional support as important enabling conditions. This framework helps distinguish economic growth from broader sustainability outcomes and explains why technological innovation may generate different results across economic contexts. From a practical perspective, businesses should prioritize green innovations that address identifiable resource inefficiencies and provide measurable economic and environmental benefits. For policymakers, the findings highlight the importance of integrating environmental regulations with financial incentives, technological assistance, and institutional capacity building. Such an approach is particularly relevant for developing economies, where limited financing and technological readiness may restrict participation in green economic transformation. Effective green economy policies should therefore promote both environmental improvement and inclusive economic opportunities rather than focusing exclusively on technological investment.

This study has several limitations that should be considered when interpreting its findings. As an integrative literature review, the analysis relies on previously published theoretical and empirical studies rather than primary data, limiting its ability to establish causal relationships or directly measure the economic and environmental effects of green innovation. Differences in geographical settings, industrial characteristics, research methods, and sustainability indicators may also affect the comparability and generalizability of the synthesized findings. Furthermore, the proposed conceptual framework has not been empirically tested, meaning that the potential mediating role of resource efficiency and the supporting roles of environmental regulation, technological capabilities, and institutional readiness remain theoretical propositions. The literature search and screening process also requires complete documentation to establish the final study corpus and improve reproducibility. Consequently, the findings should be interpreted as a conceptual synthesis rather than definitive empirical evidence of the relationships proposed.

Future research should empirically investigate the relationships proposed in the conceptual framework, particularly whether resource efficiency mediates the contribution of green innovation to economic development and how environmental regulation, technological capabilities, and institutional support influence these relationships. Comparative studies involving developed and developing economies are recommended to identify differences in technological readiness, investment accessibility, and environmental policy effectiveness. Longitudinal research would also help distinguish short-term implementation costs from

longer-term economic and environmental benefits. In addition, future studies should incorporate indicators of both relative resource efficiency and absolute environmental impacts to determine whether green innovation produces genuine sustainability improvements. From a policy perspective, governments should strengthen access to green financing, support technological development, and encourage collaboration among businesses, research institutions, and public agencies. These efforts should be accompanied by measurable sustainability indicators to ensure that green innovation contributes not only to economic productivity but also to environmental protection, social inclusion, and long-term economic resilience.

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